WHAT IS CLAIMED IS:

1. An energy-conversion system comprising:

an oxidant delivery system having an inlet and an outlet configured to deliver an oxidant-containing fluid into the energy-conversion system;

a fuel delivery system configured to deliver a fuel-containing fluid into the energy-conversion system;

a diluent delivery system configured to deliver diluent-containing fluid within the energy-conversion system, at least a portion of which comprises a vaporizable diluent fluid, and wherein at least a portion of diluent-containing fluid is pressurized as a liquid;

a combustion system, being configured to receive fluid from the fuel delivery system, the oxidant delivery system, and the diluent delivery system; and including a combustion chamber having at least one inlet in fluid communication with the outlet of the oxidant delivery system and with the outlet of the fuel delivery system; having at least one outlet, the combustion system being configured to mix fuel-containing fluid and oxidant-containing fluid to form a combustible mixture of fuel and oxidant, to oxidize fuel with oxidant, whereby forming products of oxidation, and to deliver at least a portion of liquid diluent-containing fluid into the combustion chamber; the combustion system being further configured to deliver and mix diluent-containing fluid with one or more of oxidant-containing fluid, fuel-containing fluid and products of oxidation; to constrain the peak temperature of the energetic fluid exiting the combustion system; and to form an energetic fluid within the combustion system comprising products of oxidation, and vaporized diluent fluid, the energetic fluid having elevated levels of one or more of: temperature, pressure and kinetic energy;

an expansion system comprising an expander having an inlet and an outlet configured to expand at least a portion of the energetic fluid, whereby forming an expanded fluid;

a heat and mass transfer system having a plurality of inlets and outlets, being configured to: recover heat from the expanded fluid whereby forming a cooled expanded fluid; provide heat to diluent-containing fluid whereby forming a heated

diluent fluid; deliver at least a portion of heated diluent fluid to the combustion system;

a diluent recovery system configured to recover diluent from the expanded fluid at least about equal to that delivered into the oxidant fluid or energetic fluid upstream of the outlet of the expansion system; and to recover a portion of one or both of the water formed during combustion and the water delivered with the oxidant fluid into the oxidant delivery system; and

a fluid treatment system configured to remove at least a portion of water recovered from the expanded fluid, wherein removing a portion of at least one contaminant in the expanded fluid and wherein reducing the concentration of the contaminant in the energetic fluid entering the expansion system.

2. The energy-conversion system according to claim 1 wherein the cooled energetic fluid further comprises at least one minor pollutant species formed by reaction between two or more components of fuel-containing fluid, oxidant-containing fluid, and diluent-containing fluid; the energy-conversion system being configured to control the concentration of at least that one pollutant in the utilized fluid exiting the energy conversion system to less than a prescribed concentration.

3. The energy-conversion system of claim 2 further configured to control the rate of discharge of minor pollutant species to less than 1 kg per MWh of power generated.

4. The energy-conversion system according to claim 1 comprising a combustor configured to control the spatial temperature distribution within the energetic fluid, wherein the transverse temperature distribution of the energetic fluid exiting the combustion system is controlled in at least one transverse direction in a combustor cross section near the combustor exit.

5. The energy-conversion system according to claim 1 comprising a combustor configured to control the spatial temperature distribution within the energetic fluid, wherein the temperature distribution of the energetic fluid exiting the combustion system is controlled in both the first and the second transverse directions in a combustor cross section near the combustor exit.

6. The energy-conversion system according to claim 5 comprising a combustor configured to control the spatial temperature distribution within the energetic fluid, wherein the spatial distribution of diluent and fuel-containing fluid deliveries within the combustor are controlled to achieve a substantially non-uniform temperature distribution along the first transverse direction in a combustor cross section near the combustor exit.

7. The energy-conversion system according to claim 1 comprising a combustor configured to control the spatial temperature distribution within the energetic fluid, wherein the spatial distribution of diluent and fuel-containing fluid deliveries are controlled to achieve a substantially non-uniform temperature distribution along the first transverse direction in a combustor cross section near the combustor exit.

8. The energy-conversion system according to claim 1 comprising a combustor configured to control the spatial temperature distribution within the energetic fluid, wherein the transverse distribution of temperature exiting the combustion system is controlled within +/- 10K degrees of the desired transverse temperature distribution.

9. The energy-conversion system according to claim 1 wherein the transverse distribution of the ratio of actual exit temperature to desired exit temperature is controlled within a desired transverse ratio distribution.

10. The energy-conversion system according to claim 9 wherein the temperature ratio is maintained within the range of 0.93 to 1.07.

11. The energy-conversion system according to claim 9 wherein the temperature ratio is maintained within the range of 0.97 to 1.03.

12. The energy-conversion system according to claim 9 wherein the temperature ratio near the location of peak temperature is maintained within the range of 0.99 to 1.01.

13. The energy-conversion system according to claim 9 wherein the ratio of the temperature ratio near the periphery to the temperature ratio near the center is within the range of 1.00 to 1.06.

14. The energy-conversion system according to claim 1 wherein the flow uncertainty in the flows of fuel-containing fluid, diluent-containing fluid and oxidant fluid are controlled within a selected magnitude whereby defining a temperature uncertainty, such that the peak temperature of the energetic fluid exiting the combustion system is within a selected

number of temperature uncertainties below the designed peak temperature within a desired probability, thereby increasing the system efficiency.

15. The energy-conversion system according to claim 1 wherein the delivery of diluent-containing fluid is controlled such that the diluent concentration in the energetic fluid exiting the combustion system is greater than the combustibility boundary for those fluids when fully premixed.

16. The energy-conversion system according to 1 wherein the oxidant delivery system further includes a fluid-pressurizing device configured to pressurize the oxidant-containing fluid, wherein the pressure ratio of the pressure entering the combustor to the ambient pressure is greater than about 20.

17. The energy-conversion system according to claim 16 further configured to cool the oxidant-containing fluid being compressed with diluent-containing fluid.

18. The energy-conversion system according to claim 16 further configured to deliver a portion of the heated diluent-containing fluid from the second heat exchanger into the oxidant-containing fluid being compressed.

19. The energy-conversion system according to claim 28 further comprising a recompressor configured to compress the expanded fluid to at least ambient pressure and to exhaust it.

20. The energy-conversion system according to claim 19 wherein the recompressor is configured downstream of a diluent recover system.

21. The energy-conversion system according to claim 19 wherein the gross combined expansion ratio of the product of the pressure ratios of one or more fluid pressurizing devices compressing oxidant-containing fluid upstream of the combustion chamber and the pressure ratio of the recompressor compressing the cooled expanded fluid downstream of the diluent recovery system, is greater than about 37.

22. The energy-conversion system according to claim 28 wherein the ratio of mass flow of condensible diluent to mass flow of oxidant-containing fluid is controlled such that the net specific power of the energy conversion system relative to the total oxidant-containing fluid flow, comprising the gross power of the expander less the sum of the power utilized to compress the oxidant-containing fluid, fuel-containing fluid, and diluent fluid and cooled

expanded fluid downstream of the diluent recovery system, is greater than 940 kW/(kg/s) (= kJ/kg) of fluid flow exiting the fluid pressurizing device compressing the oxidant-containing fluid wherein the oxidant is air.

23. The energy-conversion system according to claim 28 wherein the ratio of mass flow of condensible diluent to mass flow of oxidant-containing fluid is controlled such that the net specific power of the energy conversion system relative to the expander flow, comprising the gross power of the expander less the sum of the power utilized to compress the oxidant-containing fluid, fuel-containing fluid, and diluent fluid and cooled expanded fluid downstream of the diluent recovery system, is greater than 700 kW/(kg/s) (=kJ/kg) of fluid flow entering the expander when operating on air.

24. The energy-conversion system according to claim 1 wherein the recompression fluid pressurizing device compressing the cooled expanded fluid downstream of the diluent recovery system is configured to reduce the pressure of the cooled expanded fluid exiting the diluent recovery system to at least 1% less than the ambient pressure.

25. The energy conversion system of claim 24 wherein the recompressor is further configured to vary the recompression ratio of the ambient pressure to the pressure of the cooled expanded fluid.

26. The energy-conversion system according to claim 1 wherein the compression ratio of the fluid pressurizing device compressing the cooled expanded fluid downstream of the diluent recovery system is configured between 1.1 and 8.

27. The energy-conversion system according to claim 1 is further configured to control the ratio of condensible diluent to non-condensible gases in the energetic fluid, the ratio of temperature of the cooled expanded fluid to the ambient temperature, and the recompression ratio such that the concentration of diluent fluid in the fluid exiting the energy conversion system is less than a desired portion of the saturation concentration, whereby controlling the probability of a plume being formed.

28. The energy-conversion system according to 1 further comprising an expander having an inlet in fluid communication with the combustor, and an outlet, configured to expand the energetic fluid from a higher pressure at the expander inlet to a lower pressure at the expander outlet.

29. The energy-conversion system according to 28 wherein the expander is a work engine configured to convert energy contained in the energetic fluid to useful mechanical power.

30. The energy-conversion system according to claim 28 wherein the fluid delivery and expansion ratio are configured and controlled such that the exit temperature of fluid exiting the expander is less than 500 degrees Celsius.

31. The energy-conversion system according to claim 28 further configured and configured to control the fluid delivery and expansion ratio such that the diluent concentration of the energetic fluid exiting the expander is less than the saturation concentration, whereby diluent does not condense within the expander.

32. The energy-conversion system according to 29 further comprising an electrical generator mechanically connected to the expander and configured to convert at least a portion of the mechanical power to electrical power.

33. The energy-conversion system according to claim 32 wherein the heat and mass transfer system further comprises a heat exchanger configured to recover heat from the electrical generator and to heat diluent-containing fluid.

34. The energy-conversion system according to claim 33 further configured to control the flow of diluent-containing fluid through the electrical generator heat exchanger and to maintain the temperature of the electrical generator below a desired level.

35. The energy-conversion system according to claim 33 further configured to use a low viscosity fluid to cool the electrical generator and exchange heat with the diluent-containing fluid.

36. The energy-conversion system according to claim 33 further configured to mix at least a portion of the heated diluent comprising heat from the electrical generator, with fluid upstream of the outlet of the expander.

37. The energy-conversion system according to 29 further comprising an expander drive connecting the expander to a mechanical application and wherein the heat and mass transfer system further comprises a heat exchanger configured to recover heat from the expander drive and deliver heated diluent-containing fluid.

38. The energy-conversion system according to claim 37 further configured to maintain the temperature of the drive lubricant to below a desired temperature.

39. The energy-conversion system according to claim 1 further comprising

a heat generating component one or more of a generator connected to the expander, a motor, an electromagnetic converter, and an electromagnetic controller; and

the heat and mass transfer system further comprising a component heat exchanger configured to control the flow of diluent-containing fluid wherein controlling the temperature of the heat generating component and recovering heat into heated diluent-containing fluid.

40. The energy-conversion system according to claim 39 further configured to control the flow of diluent-containing fluid such that the temperature of the electronic converter is maintained below 100 degrees Celsius.

41. The energy-conversion system according to claim 28 further comprising at least a second expander, configured to extract power from the energetic fluid at greater than 1.5 times the power extractable by the first expander at design conditions.

42. 42. The energy-conversion system according to claim 1 wherein the controller is configured to control the fluid delivery such that the temperature of the energetic fluid entering the expander is controlled to not exceed a desired temperature.

43. The energy-conversion system according to 1 further comprising a fuel treatment system in fluid communication with the diluent delivery system, configured to treat the fuel-containing fluid and deliver it for use in the energy-conversion system.

44. The fuel treatment system according to 43 further comprising a cleaning means configured to remove at least a portion of the contaminants in the fuel-containing fluid.

45. The fuel treatment system according to claim 44 further configured to filter off the contaminants from the fuel-containing fluid larger than a desired size.

46. The energy-conversion system according to claim 1 wherein heat from the energetic fluid downstream of the expander is exchanged with fuel-containing fluid being delivered to the combustion system.

47. The energy-conversion system according to claim 1 wherein the temperature of the fuel-containing fluid is maintained below a desired temperature prior to delivery into the combustion system, to substantially maintain the desired delivery of fuel-containing fluid.

48. The energy-conversion system according to claim 47 the heat recovery is controlled such that the fuel-containing fluid temperature is maintained below about 100 degrees Celsius prior to delivery into the combustion system.

49. The energy-conversion system according to 1 further comprising a diluent treatment system in fluid communication with the diluent delivery system and configured to prepare the diluent for use in the energy-conversion system.

50. The diluent treatment system according to 49 further comprising a cleaning means configured to remove at least a portion of the contaminants from at least a portion of the diluent-containing fluid.

51. The diluent treatment system according to claim 50 further configured to filter off the contaminants larger than a desired size from at least a portion of the diluent-containing fluid.

52. The diluent treatment system according to claim 50 further configured to remove at least a portion of the soluble contaminants from the diluent-containing fluid.

53. The diluent treatment system according to claim 49 further configured to remove a portion of the recovered diluent from the energy conversion system.

54. The diluent treatment system according to claim 53 further configured to remove a portion of diluent from the energy conversion system whereby removing at least a portion of at least one contaminant from the energy conversion system, wherein maintaining the concentration of at least that contaminant entering the expander to less than a desired value.

55. The diluent treatment system according to claim 49 further configured to reduce a concentration of a diluent component to less than a desired value in at least a portion of diluent-containing fluid, wherein when at least portion of that diluent is delivered upstream of the outlet of the expander, the concentration of that component in the energetic fluid delivered to the expander is less than a desired concentration.

56. The energy-conversion system according to claim 1 further configured to recycle a portion of the recovered diluent to upstream of the combustion system outlet.

57. The energy-conversion system according to claim 56 configured to reduce the portion of contaminants in a portion of the recovered diluent.

58. The energy-conversion system according to claim 57 further configured to sufficiently purify the diluent such that the total concentration of at least one contaminant in energetic fluid comprising that purified diluent recovered is less than a desired level.

59. The energy-conversion system according to claim 1 further comprising a diluent recovery system configured to recover a portion of diluent from the utilized fluid.

60. The diluent treatment system according to claim 59 further configured to control the portion of diluent removed from the energy conversion system wherein controlling the amount of diluent within the energy conversion system.

61. The diluent recovery system according to claim 59 further configured to recover a portion of diluent from the utilized fluid at least equal to the portion delivered upstream of the outlet of the expander.

62. The diluent recovery system according to claim 61 further configured to recover a portion of diluent equal to or greater than the portion of diluent delivered upstream of the outlet of the expander plus a portion desired to be removed from the energy conversion system.

63. The energy-conversion system according to claim 59 further configured to recover a portion of diluent from the utilized fluid to be equal to the portion deliverable upstream of the outlet of the expander plus a portion of diluent formable in combustion plus a portion of the relative humidity receivable through the incoming oxidant-containing fluid.

64. The energy-conversion system according to claim 1 configured to use water as a diluent in the diluent-containing fluid.

65. The energy-conversion system according to claim 1 wherein the diluent recovery system comprises a direct contact condenser.

66. The energy-conversion system according to claim 65 wherein the approach temperature between the coolant fluid entering the diluent recovery system and the

temperature of the cooled energetic fluid exiting the diluent recovery system is less than 20 K (36 Fahrenheit degrees).

67. The energy-conversion system according to claim 65 wherein the approach temperature between cool diluent fluid entering the diluent recovery system and the temperature of the cooled energetic fluid exiting the diluent recovery system is less than 4 K (7.2 Fahrenheit degrees).

68. The energy-conversion system according to claim 1 wherein the diluent recovery system further removes a portion of filterable contaminants from the cooled expanded energetic fluid.

69. The energy-conversion system according to claim 1 wherein the diluent recovery system further removes a portion of soluble contaminants from the cooled expanded energetic fluid.

70. The energy-conversion system according to 1 further including a first heat exchanger having a hotter inlet in fluid communication with the expander outlet, and a cooler outlet, to exchange heat from at least a portion of the expanded energetic fluid with at least a portion of diluent-containing fluid.

71. The energy-conversion system according to claim 70 wherein a portion of heated diluent is delivered to the combustion system.

72. The energy-conversion system according to 1 further including a diluent recovery system in fluid communication with the outlet of the expander and configured to recover diluent fluid.

73. The diluent recovery system according to claim 72 configured to recover at least a desired a portion of diluent from the utilized fluid exiting the expander.

74. The energy-conversion system according to 72 configured to recycle at least a portion of recovered diluent fluid within the energy-conversion system.

75. The energy-conversion system according to claim 70 wherein the heat exchanger is downstream of an expander.

76. The energy-conversion system according to claim 75 further configured to recover at least a portion of diluent fluid from the expanded fluid.

77. The energy-conversion system according to claim 76 wherein at least a portion of the heated diluent-containing fluid is delivered to the combustion system.

78. The energy-conversion system according to claim 1 wherein a portion of the diluent is mixed with flue containing fluid upstream of combustion.

79. The energy-conversion system according to claim 1 wherein a portion of the diluent is mixed with oxidant-containing fluid upstream of combustion.

80. The energy-conversion system according to 1 further comprising a second heat exchanger downstream of the first heat exchanger to exchange heat of at least a portion of the energetic fluid with at least a portion of cooler diluent to cool the energetic fluid.

81. The energy-conversion system according to claim 1 wherein the heat and mass transfer system further comprises a second heat exchanger downstream of the first heat exchanger.

82. The energy-conversion system according to claim 81 wherein the heat and mass transfer system is configured such that the ratio of the area of the second heat exchanger to area of the first heat exchanger is in the range of 20% to 150%.

83. The energy-conversion system according to claim 81 wherein heat from the expanded fluid flowing through the second downstream heat exchanger is recovered by liquid diluent.

84. The energy-conversion system according to claim 81 wherein a portion of the liquid diluent heated in the second downstream heat exchanger is delivered to cool oxidant-containing fluid being compressed by the oxidant fluid pressure device.

85. The energy-conversion system according to claim 81 further comprising a device configured to control the flow rates of thermal diluent being delivered from the second heat exchanger to the first heat exchanger and being delivered to the oxidant delivery system.

86. The energy-conversion system according to claim 81 further comprising a device configured to control the flow rates of thermal diluent being delivered from the second heat exchanger to the intake to the oxidant delivery system and into compressed oxidant-containing fluid within the oxidant delivery system.

87. The energy-conversion system according to claim 1 wherein the portion of the flow of heated liquid diluent delivered to the oxidant fluid pressure device is less than or

equal to that required to saturate the oxidant-containing fluid exiting the oxidant pressurizing device.

88. The energy-conversion system according to claim 1 wherein the heat and mass transfer system further comprises a condensation heat recovery system downstream of the first heat exchanger using a coolant fluid to recover heat from at least a portion of the energetic fluid sufficient to condense at least a portion of the vaporized diluent fluid.

89. The energy-conversion system according to claim 1 wherein the heat and mass transfer system further comprises a cooling system to cool the coolant used to cool the expanded fluid and condense the vaporized diluent.

90. The energy-conversion system according to claim 89, wherein the condensation heat recovery system comprises a direct contact heat exchanger utilizing diluent as the coolant fluid.

91. The energy-conversion system according to claim 90 wherein the direct contact heat and mass transfer system and the coolant diluent flow is configured such that the approach temperature between the cooled utilized fluid exiting the direct contact heat exchanger and the heated coolant diluent is less than 4 degrees Celsius.

92. The energy-conversion system according to claim 1 wherein the heat and mass transfer system comprises a third heat exchanger downstream of the expander and upstream of the first heat exchanger to recover heat from the expanded fluid and to heat a coolant fluid.

93. The energy-conversion system according to claim 92 further comprising a device configured to control the flow rates of thermal diluent being delivered from the first heat exchanger to the second heat exchanger and being delivered to the combustion system.

94. The energy-conversion system according to claim 92 wherein the coolant fluid comprises liquid thermal diluent and at least a portion of the thermal diluent is evaporated in the third heat exchanger.

95. The energy-conversion system according to claim 92 wherein the coolant fluid is thermal diluent and at least a portion of the thermal diluent is evaporated and further heated in the third heat exchanger to form a superheated diluent.

96. The energy-conversion system according to claim 92 wherein the coolant side of the third heat exchanger is in fluid communication with the combustion system downstream of the compressor and upstream of the expander.

97. The energy-conversion system according to claim 92 wherein diluent heated by the third heat exchanger is mixed with fluid within the combustion system downstream of the oxidant compressor and upstream of the expander.

98. The energy-conversion system according to claim 92 wherein diluent heated by the third heat exchanger is mixed with fluid upstream of the start of combustion.

99. The energy-conversion system according to claim 1 wherein the heat and mass transfer system further comprises a recuperative heat exchanger configured to recover heat from the expanded fluid exiting the expander and to heat oxidant-containing fluid upstream of the combustion system.

100. The energy-conversion system according to claim 99 wherein the heat and mass transfer system is configured such that the ratio of heat recovery surface areas of the recuperative heat exchanger to the diluent heat exchanger is from 20% to 300%.

101. The energy-conversion system according to claim 99 wherein the heat and mass transfer system is configured such that the portion of expanded fluid directed through the heat exchanger downstream of the expander is similar to the portion of the expanded fluid directed through the recuperative heat exchanger heating oxidant-containing fluid upstream of the combustion system.

102. The system of claim 1 wherein the fluid treatment system further being configured to treat one or more of the diluent fluid, the fuel-containing fluid, and the oxidant-containing fluid to reduce the concentration of at least one component of the energetic fluid entering the expansion system.

103. A heat and mass transfer system conversion at least two inlets and at least one outlet for use in conjunction with an energy-conversion system which comprises:

an oxidant delivery system configured to deliver an oxidant-containing fluid to the energy-conversion system;

a fuel delivery system configured to deliver a fuel-containing fluid to the energy-conversion system;

a diluent delivery system configured to directly inject a diluent-containing fluid comprising a vaporizable diluent fluid directly into the energy-conversion system;

a combustion system, comprising a combustion chamber configured to react a portion of fuel-containing fluid and a portion of the oxidant-containing fluid, and to evaporate a portion of the liquid diluent to form an energetic fluid;

an expansion system comprising at least one expansion device, configured to expand at least some of the energetic fluid to produce an expanded fluid;

a heat exchanger configured to exchange heat of at least a portion of the expanded fluid with at least a portion of the diluent-containing fluid; and

a heat recovery system downstream of the heat exchanger configured to recover heat from at least a portion of the expanded fluid to form a cooled fluid and thereby recover at least a portion of the diluent injected into the energy conversion system;

wherein the heat and mass transfer system recovers at least one element from the group consisting of: at least some heat that would otherwise be exhausted with energetic fluid and converts at least some of the heat into useful mechanical work, and at least some heated fluid and uses the fluid for heating in some other application, and at least some of the diluent fluid, at least some of the coolant fluid, and at least some water produced by the oxidation.

104. The heat and mass transfer system according to claim 103 wherein the expansion system comprises at least one re-compression device configured to recompress the expanded fluid.

105. The heat and mass transfer system according to 103 wherein the combustion system is insulated so as to reduce heat loss from the combustion system.

106. The heat and mass transfer system according to 103 wherein the combustion system comprises insulation configured to reduce heat gain, by components of the combustion system, from one of the combustion and the energetic fluid.

107. The heat and mass transfer system according to 103 wherein the combustion system comprises at least one radiation shield configured to intercept radiation from at least one of the combusting fluids and the energetic fluid.

108. The heat and mass transfer system according to 103 wherein the combustion system also comprises a cooling system.

109. The heat and mass transfer system according to 108 wherein the cooling system comprises a device for enabling surface heat exchange between the fluid within the combustion chamber and a cooler fluid supplied to the cooling system.

110. The heat and mass transfer system according to 108 wherein the cooling system comprises a device for enabling direct contact heat exchange between the fluid within the combustion chamber and a cooler diluent-containing fluid supplied by the cooling system.

111. The heat and mass transfer system according to 103 wherein the heat and mass transfer system delivers a portion of diluent-containing fluid to the oxidant-delivery system for cooling of the oxidant-containing fluid by a heat exchange device followed by return of the diluent-containing fluid to the heat and mass transfer system.

112. The heat and mass transfer system according to 103 wherein the heat and mass transfer system delivers a portion of diluent-containing fluid to the oxidant-delivery system for cooling of the oxidant-containing fluid by a surface heat exchange device followed by return of the diluent-containing fluid to the heat and mass transfer system.

113. The heat and mass transfer system according to 111 wherein the heat exchange device is placed upstream of a re-compression device.

114. The heat and mass transfer system according to 103 wherein the heat and mass transfer system delivers a portion of diluent-containing fluid to the oxidant-delivery system for mixing with at least a portion of oxidant-containing fluid by a fluid-mixing device in the oxidant delivery system.

115. The heat and mass transfer system according to 114 wherein the mixing device is placed before or after any of the compression devices.

116. The heat and mass transfer system according to 114 wherein the mixing device injects a portion of the diluent-containing fluid directly into at least one of the compression device.

117. The heat and mass transfer system according to 103 wherein at least a portion of the oxidant-containing fluid within the oxidant delivery system is cooled by a cooling device.

118. The heat and mass transfer system according to 117 wherein the cooling device is placed before or after any of the compression devices.

119. The heat and mass transfer system according to 103 wherein at least a portion of the oxidant-containing fluid is supplied from the oxidant-delivery system to the heat and mass transfer system for further processing.

120. The heat and mass transfer system according to 103 further including at least one heat exchanger on at least one of the following heat generating components:

an electric generator;

a turbine generator drive;

an electronic converter,

wherein that component is cooled.

121. The heat and mass transfer system according to 120 wherein the heat generating component is cooled by diluent containing fluid.

122. The heat and mass transfer system according to 103 wherein the fuel delivery system supplies a portion of fuel-containing fluid to the heat and mass transfer system for further processing.

123. The heat and mass transfer system according to 103 wherein the diluent delivery system supplies a portion of diluent-containing fluid to the heat and mass transfer system for further processing.

124. The heat and mass transfer system according to 103 further configured to deliver a portion of the oxidant-containing fluid to the combustion chamber.

125. The heat and mass transfer system according to 103 further configured to deliver a portion of the fuel-containing fluid to the combustion chamber.

126. The heat and mass transfer system according to 103 further configured to deliver a portion of the diluent-containing fluid to the combustion chamber.

127. The heat and mass transfer system according to 109 further configured to deliver a portion of some fluid to the cooling system within the combustion system after which it is returned to the heat and mass transfer system.

128. The heat and mass transfer system according to 103 further configured to deliver a portion of the diluent-containing fluid to the expansion system for cooling of expanded fluid within the expansion system by a surface heat exchange device followed by return of the diluent-containing fluid to the heat and mass transfer system.

129. The heat and mass transfer system according to 111 wherein the heat exchange device is placed downstream of the expansion devices and upstream of the re-compression devices.

130. The heat and mass transfer system according to 111 wherein the heat exchange device is placed downstream of the re-compression devices.

131. The heat and mass transfer system according to 103 wherein the heat and mass transfer system delivers a portion of the diluent-containing fluid to the expansion system for mixing with some fluid by a fluid-mixing device in the expansion system.

132. The heat and mass transfer system according to 131 wherein the mixing device is placed before or after any of the expansion devices, or the re-compression devices.

133. The heat and mass transfer system according to 131 wherein the mixing device injects a portion of the diluent-containing fluid directly into at least one of the expansion devices, or the re-compression devices.

134. The heat and mass transfer system according to 103 wherein a portion of some fluid within the expansion system is cooled by some cooling device.

135. The heat and mass transfer system according to 134 wherein the cooling device is placed before or after any of the expansion devices or the re-compression devices,

136. The heat and mass transfer system according to 103 wherein at least a portion of some fluid within the expansion system is supplied to the heat and mass transfer system for further processing.

137. The heat and mass transfer system according to 103 wherein the heat and mass transfer system delivers a portion of some fluid to the expansion system.

138. The heat and mass transfer system according to 103 wherein the energy-conversion system comprises at least one pump.

139. The heat and mass transfer system according to 103 wherein the heat and mass transfer system delivers at least a portion of diluent-containing fluid and/or coolant fluid for the purposes of cooling at least one pump within the energy-conversion system.

140. The heat and mass transfer system according to 103 wherein the heat and mass transfer system delivers at least some heat to the environment or to another process.

141. The heat and mass transfer system according to 103 wherein the heat and mass transfer system delivers a portion of diluent-containing fluid to the environment or to another process.

142. The heat and mass transfer system according to 103 wherein the heat and mass transfer system delivers a portion of exhaust gas to the environment or to another process outside the energy-conversion system.

143. The heat and mass transfer system according to 103 wherein the heat and mass transfer system delivers a portion of hot fluid to another process outside the energy-conversion system.

144. The heat and mass transfer system according to 143 wherein the hot fluid is used in another process outside the energy-conversion system and then at least a portion of it is returned to the heat and mass transfer system.

145. The heat and mass transfer system according to 143 wherein the hot fluid is vaporized diluent-containing fluid.

146. The heat and mass transfer system according to 143 wherein the hot fluid is hot liquid diluent-containing fluid.

147. The heat and mass transfer system according to 143 wherein the hot fluid is used to provide energy for a refrigeration process.

148. The heat and mass transfer system according to 103 wherein a portion of the liquid diluent-containing fluid or the coolant fluid is heated by the exhaust or the energetic gas by the use of a surface heat exchange device.

149. The heat and mass transfer system according to 148 wherein at least a portion of the heated diluent-containing fluid or the coolant fluid is injected directly into the combustion chamber.

150. The heat and mass transfer system according to 148 wherein at least a portion of the heated diluent-containing fluid or the coolant fluid is used to cool the oxidant-containing fluid.

151. The heat and mass transfer system according to 148 wherein at least a portion of the heated diluent-containing fluid or the coolant fluid is used to heat the fuel by a surface heat exchange device and wherein the fuel is delivered to the combustion chamber.

152. The heat and mass transfer system according to 148 wherein at least a portion of the heated diluent-containing fluid or the coolant fluid is mixed using some mixing device with the fuel and wherein the fuel is delivered to the combustion chamber.

153. The heat and mass transfer system according to 148 wherein at least a portion of the evaporated diluent-containing fluid is mixed with a portion of the fuel using some mixing device and wherein the fuel is delivered to the combustion chamber.

154. The heat and mass transfer system according to 153 wherein at least a portion of the fuel-containing fluid is vaporized and wherein at least a portion of the fuel-containing fluid is delivered to the combustion chamber.

155. The heat and mass transfer system according to 103 wherein at least a portion of the heated diluent-containing fluid or the coolant fluid is used in a heating process outside the energy-conversion system.

156. The heat and mass transfer system according to 103 wherein at least a portion of the liquid diluent-containing fluid is evaporated by the exhaust or the energetic gas by the use of some surface heat exchange device.

157. The heat and mass transfer system according to 156 wherein at least a portion of the evaporated diluent-containing fluid is injected directly into the combustion chamber.

158. The heat and mass transfer system according to 156 wherein at least a portion of the evaporated diluent-containing fluid is used in a heating process requiring vaporized fluid outside the energy-conversion system.

159. The heat and mass transfer system according to 158 wherein at least a portion of the diluent-containing fluid which is used in a heating process requiring vaporized fluid is returned to the heat and mass transfer system.

160. The heat and mass transfer system according to 156 wherein at least a portion of the evaporated diluent-containing fluid is used to heat a portion of fuel-containing fluid in a surface heat exchange device and wherein a portion of the fuel is delivered to the combustion chamber.

161. The heat and mass transfer system according to 103 wherein at least a portion of the vaporized diluent-containing fluid is further heated by the exhaust or the energetic gas by the use of a surface heat exchange device.

162. The heat and mass transfer system according to 161 wherein at least a portion of the further-heated diluent-containing fluid is injected directly into the combustion chamber.

163. The heat and mass transfer system according to 161 wherein at least a portion of the further-heated diluent-containing fluid is used in a heating process requiring vaporized fluid outside the energy-conversion system.

164. The heat and mass transfer system according to 163 wherein at least a portion of the diluent-containing fluid which is used in a heating process requiring vaporized fluid is returned to the heat and mass transfer system.

165. The heat and mass transfer system according to 161 wherein at least a portion of the further-heated diluent-containing fluid is used to heat at least a portion of the fuel-containing fluid by some surface heat exchange device and wherein the fuel-containing fluid is delivered to the combustion chamber.

166. The heat and mass transfer system according to 161 wherein at least a portion of the heated diluent-containing fluid is mixed with a portion of the fuel-containing fluid using some mixing device and wherein the fuel is delivered to the combustion chamber.

167. The heat and mass transfer system according to 166 wherein at least a portion of the fuel-containing fluid is vaporized and wherein at least a portion of the fuel-containing fluid is delivered to the combustion chamber.

168. The heat and mass transfer system according to 103 wherein at least a portion of the diluent-containing fluid or water is condensed from a portion of the energetic or a portion of the exhaust gas diluent-containing fluid by the use of a surface condensation device.

169. The heat and mass transfer system according to 103 wherein at least a portion of the diluent-containing fluid or water is condensed and recovered from a portion of the energetic or the exhaust gas diluent-containing fluid by the use of a direct fluid contacting device.

170. The heat and mass transfer system according to 168 and 169 wherein a portion of the energetic or the exhaust gas is cooled by a portion of the cooling fluid.

171. The heat and mass transfer system according to 170 wherein at least a portion of the cooling fluid has heat removed from it by a cooling device and is then re-cycled for further cooling by use of a pump or other re-circulating device.

172. The heat and mass transfer system according to 171 wherein at least a portion of the diluent-containing fluid or water that is condensed and recovered is re-cycled to the cooling device.

173. The heat and mass transfer system according to 171 wherein a portion of the diluent-containing fluid or water that is condensed and recovered is used for other purposes within the heat and mass transfer system.

174. The heat and mass transfer system according to 171 wherein a portion of the diluent-containing fluid or water that is condensed and recovered is used for a heating process outside of the heat and mass transfer system.

175. The heat and mass transfer system according to 171 wherein a portion of the diluent-containing fluid or water that is for a heating process outside of the heat and mass transfer system is returned to the heat and mass transfer system.

176. The heat and mass transfer system according to 171 wherein a portion of the diluent-containing fluid or water that is condensed and recovered is discharged from the energy-conversion system.

177. The heat and mass transfer system according to 170 wherein at least a portion of the cooling fluid is used for various purposes inside of the heat and mass transfer system.

178. The heat and mass transfer system according to 170 wherein at least a portion of the cooling fluid is used for a heating process outside of the heat and mass transfer system.

179. The heat and mass transfer system according to 178 wherein a portion of the diluent-containing fluid or water that is for a heating process outside of the heat and mass transfer system is returned to the heat and mass transfer system.

180. The heat and mass transfer system according to 168 and 169 wherein a portion of the energetic gas or exhaust gas leaving the condensation device is exhausted from the energy-conversion system.

181. The heat and mass transfer system according to 168 and 169 wherein a portion of the energetic gas or exhaust gas leaving the condensation device is delivered to one of the re-compressors in the exhaust system.

182. The heat and mass transfer system according to 103 configured to heat at least a portion of the oxidant-containing fluid by a portion of the expanded fluid or cooled expanded fluid by use of a surface heat exchange device.

183. The heat and mass transfer system according to 103 wherein at least a portion of the oxidant-containing stream is brought into contact with at least a portion of the diluent-containing fluid or a portion of the coolant fluid in a fluid-contacting device in which at least a portion of the diluent-containing fluid or a portion of the coolant fluid evaporates into the oxidant-containing fluid.

184. The heat and mass transfer system according to 103 further including at least one device configured to circulate at least one of the fluids.

185. The heat and mass transfer system according to 103 further including at least one device configured to increase the pressure of least one of the fluids to a higher value.

186. The heat and mass transfer system according to 103 further including at least one device configured to decrease the pressure of least one of the fluids to a lower value.

187. A method of controlling heat and mass transfer within an energy conversion system, the energy conversion system comprising:

A combustor configured to receive oxidant-containing fluid, fuel-containing fluid and diluent-containing fluid, comprising a combustion chamber

configured to react at least a portion of fuel from the fuel-containing fluid with at least a portion of oxidant from said oxidant-containing fluid,

whereby forming an energetic fluid comprising products of reaction and residual components from the oxidant-containing fluid, fuel-containing fluid and diluent-containing fluid, having elevated levels of at least one of temperature, pressure and velocity;

an oxidant delivery system configured to deliver an oxidant-containing fluid to the combustor;

a fuel delivery system configured to deliver a fuel-containing fluid to the combustor;

a diluent delivery system configured to deliver diluent-containing fluid comprising a vaporizable diluent fluid to the combustor;

a fluid expansion system, comprising at least one expansion device, configured to expand at least some of said energetic fluid, whereby forming an expanded energetic fluid;

a heat and mass transfer system, comprising at least one heat exchanger and having at least two inlets and one outlet, configured to:

exchange heat from at least a portion of the expanded energetic fluid with a coolant fluid, and to

transfer mass between the diluent-containing fluid and at least one of the oxidant-containing fluid, the energetic fluid, and the expanded energetic fluid;

a control system, comprising a controller, configured to control: the fuel-containing fluid delivered by the fuel delivery system, the diluent-containing fluid delivered by the diluent delivery system, the mass transfer between the diluent-containing fluid and at least two of the oxidant-containing fluid, the energetic fluid, and the expanded energetic fluid; and the distribution of diluent delivery within the energy conversion system; the control method comprising: controlling the delivery of fuel-containing fluid within the combustion system; controlling the delivery of oxidant-containing fluid within

the combustion system; controlling the mass transfer between diluent-containing fluid and at least two of oxidant-containing fluid, energetic fluid, and expanded energetic fluid within the energy conversion system; and controlling the distribution of diluent-containing fluid delivery within the energy conversion system;

wherein controlling the peak temperature of the energetic fluid exiting the combustor to less than a prescribed expander peak temperature and recovering heat from the expanded fluid.

188. The control method of claim 187 further comprising controlling the delivery of diluent upstream of the expansion system.

189. The control method of claim 187 further comprising controlling the delivery of diluent-containing fluid to the oxidant delivery system.

190. The control method of claim 187 further comprising controlling the delivery of diluent-containing fluid to the combustion system.

191. The control method of claim 187 further comprising controlling the coolant fluid delivered to the expanded fluid heat exchanger wherein recovering heat from the expanded energetic fluid into the coolant fluid.

192. The control method of claim 187 wherein the coolant fluid comprises diluent-containing fluid, the control method further comprising controlling the diluent-containing fluid delivered to the expanded fluid heat exchanger whereby recovering heat from the expanded energetic fluid into the diluent.

193. The control method of claim 192 further comprising controlling the temperature of the cooled expanded energetic fluid.

194. The control method of claim 187 the energy conversion system further comprising a diluent recovery system, the control method of claim 187 further comprising controlling the portion of diluent recovered from the expanded energetic fluid.

195. The control method of claim 187 the method further comprising controlling the delivery of a coolant fluid comprising one of diluent-containing fluid and oxidant-containing fluid, to a component of the energy conversion system heated by the energetic

fluid, wherein controlling the temperature of that component to not exceed a prescribed temperature.

196. The control method of claim 187 the method further exchanging heat to recover a portion of the diluent in the expanded energetic fluid, whereby forming a cooled expanded fluid and a heated coolant fluid, and wherein the coolant fluid comprises at least a portion of diluent.

197. The control method of claim 187 where in the expansion system further comprises a recompression device configured to recompress the cooled energetic fluid after recovery of diluent whereby forming an exhaust fluid, and exhausting the exhaust fluid to ambient conditions, the control method further comprising controlling the pressure of the cooled expanded energetic fluid entering the recompression device.

198. The control method of claim 197 further controlling the pressure of the cooled expanded energetic fluid upstream of the recompression device to greater than about 80% of the ambient pressure.

199. The control method of claim 197 further controlling the pressure of the cooled expanded energetic fluid upstream of the recompression device to less than or equal to about 80% of the ambient pressure.

200. The control method of claim 187 wherein the diluent-containing fluid comprises a chemical component formable by the reaction, the method further comprising controlling the portion of diluent recovered from the expanded energetic fluid to be equal to or greater than the amount of diluent delivered upstream of the expansion system.

201. The control method of claim 200 wherein the diluent comprises water, the method further comprising controlling the portion of diluent recovered from the expanded energetic fluid to further include a portion of the relative humidity in the oxidant-containing fluid received by the oxidant delivery system.

202. The control method of claim 200 further comprising controlling the portion of diluent recovered from the expanded energetic fluid to include all the relative humidity in the oxidant-containing fluid received by the oxidant delivery system, further including a portion of diluent formed by the combustion process.

203. The control method of claim 202 further comprising controlling the portion of diluent recovered from the expanded energetic fluid to further include substantially all the water formed by the combustion process.

204. The control method of claim 187 wherein the energy conversion system further comprises a heat generation device which comprises a heat exchanger.

the device being selected from a generator, a motor, a mechanical drive, a pump, a bearing, an electromagnetic energy converter, and an electromagnetic controller;

wherein the controller is configured to control the flow of coolant diluent fluid through the heat exchanger, the control method further comprising controlling the flow of coolant diluent wherein the temperature of the heat generation device is maintained below a generation device temperature limit.

205. The control method of claim 204 further comprising controlling the temperature of the heat generation device to less than about 343 degrees C (650 degrees F).

206. The control method of claim 204 further comprising controlling the temperature of the heat generation device to less than about 100 degrees C (212 degrees F).

207. The control method of claim 187 wherein the energy conversion system further comprises a hot section configured to contact energetic fluid, and comprises a hot section heat exchanger;

the hot section being selected from one of a combustion chamber, a fuel-containing fluid delivery component, a flame authority, an equilibration chamber, a turbine blade, a turbine vane, and a turbine shroud;

wherein the controller is configured to control the flow of coolant diluent fluid through the heat exchanger,

the control method further comprising controlling the flow of coolant diluent wherein the temperature of the hot section is maintained below a prescribed hot section temperature limit.

208. The control method of claim 187 wherein the heat and mass transfer system is configured to deliver heated diluent-containing fluid to the combustor, the control method further comprising controlling the portion of heated diluent-containing fluid that is delivered

into one or both of the oxidant-containing fluid and the energetic fluid upstream of the expansion system.

209. The control method of claim 187 further comprising controlling the portion of diluent-containing fluid mixed with oxidant-containing fluid to be less than 110% of the level saturating the oxidant-containing fluid, prior to that diluted oxidant-containing fluid entering the combustor.

210. The control method of claim 197 wherein the heat and mass transfer system further comprising an exhaust heat exchanger downstream of the recompressor, the control method further comprising controlling the portion of diluent-containing fluid flowing through the exhaust heat exchanger, whereby forming a heated diluent-containing fluid.

211. The control method of claim 210 further controlling the relative humidity of the exhaust fluid exiting the energy conversion system, whereby affecting the probability of forming a plume.

212. The control method of claim 187 wherein the heat and mass transfer system is configured to deliver vaporized diluent-containing fluid to the combustor, the method further comprising controlling the portion of vaporized diluent that is delivered into one or both of the oxidant-containing fluid and the energetic fluid upstream of the expansion system.

213. The control method of claim 187 wherein the heat and mass transfer system is configured to deliver superheated vaporized diluent to the combustor, the method further comprising controlling the portion of superheated vaporized diluent that is delivered into one or both of the oxidant-containing fluid and the energetic fluid upstream of the expansion system.

214. The control method of claim 187 further comprising controlling the delivery of diluent-containing fluid into the oxidant-containing fluid wherein controlling the degree of saturation by diluent of the oxidant-containing fluid delivered by the oxidant delivery system.

215. The control method of claim 187 further comprising controlling the portions of total diluent delivered by the diluent-containing fluid and diluent fluid delivered with the oxidant-containing fluid.

216. The control method of claim 187 wherein the oxidant-containing fluid is air, and the diluent-containing fluid comprises water, the control method further comprising

controlling the ratio of water to air delivered upstream of the expansion system to be greater 25% by mass.

217. The control method of claim 187 the method further comprising controlling the distribution of diluent-containing fluid delivery wherein the amount of diluent in the oxidant-containing fluid entering the flame front within the combustor exceeds the amount required to saturate the oxidant-containing fluid with diluent.

218. The control method of claim 187 the method further comprising controlling the distribution of diluent delivery wherein the amount of oxidant-containing fluid, fluid containing fluid and diluent-containing fluid forming the energetic fluid if uniformly mixed would form a non-combustible mixture given the respective conditions at which those fluids are delivered to the combustion system.

219. The control method of claim 187 the method further comprising controlling one or both of the delivery of oxidant-containing fluid and fuel-containing fluid, wherein the degree of reaction within the combustor is sufficient to control at least one of the non-oxidized fuel components in the exhaust fluid to less than a desired concentration.

220. The control method of claim 187 the method further comprising controlling the distribution of diluent delivery wherein the degree of reaction within the combustor is sufficient to control the byproduct components in the exhaust fluid to less than a desired concentration.

221. A method of controlling a heat and power system, the heat and power system comprising:

a reactant delivery system configured to deliver a reactant fluid comprising a reactant;

a co-reactant delivery system configured to deliver a co-reactant fluid comprising a co-reactant;

a diluent delivery system configured to deliver a diluent fluid comprising a vaporizable diluent;

a reactor configured to deliver diluent, react reactant with co-reactant and form an energetic fluid comprising reaction products, diluent and residual components of the co-reactant fluid and diluent fluid;

an expander configured to expand the energetic fluid and extract mechanical energy, whereby forming an expanded fluid;

a hot fluid heat exchanger configured to recover thermal energy from at least one of the energetic fluid and the expanded fluid, into a coolant fluid whereby forming a heated fluid and a cooled fluid;

a heated component heat exchanger, configured to control the temperature of the heated component and recover heat into a coolant fluid;

a controller configured to control the delivery of reactant fluid, co-reactant fluid and diluent fluid;

the method comprising:

controlling the delivery of coolant fluid to the heated component heat exchanger wherein controlling the temperature of the heated component to less than a selected temperature;

controlling the diluent fluid delivered into the co-reactant containing fluid or energetic fluid upstream of the expander outlet, wherein controlling the peak temperature of the energetic fluid entering the expander to below a specified temperature;

controlling the delivery of coolant fluid through the hot fluid heat exchanger wherein recovering heat from the energetic fluid and

controlling the temperature of the heated fluid to be greater than a selected temperature;

controlling the reactant fluid delivery to provide a thermal energy at least equal to the thermal energy sufficient to deliver the sum of a mechanical energy extracted from the energetic fluid by the expander, plus a thermal energy extracted from the energetic fluid or expanded energetic fluid and delivered by the coolant fluid;

controlling one or both of the reactant fluid and the co-reactant fluid to obtain a ratio lambda of the co-reactant to reactant ratio relative to the stoichoimetric co-reactant to reactant ratio within a selected range above one and below a selected ratio;

controlling diluent delivery within the reactor; wherein controlling the amount of oxides of nitrogen and amount of reactant pollutant components in the expanded fluid being exhausted from the energy conversion system.

222. The control method of claim 221 wherein the heated fluid comprises diluent.

223. The control method of claim 221 wherein the reactant is a fuel comprising one or more of hydrogen and carbon.

224. The control method of claim 221 wherein the co-reactant is an oxidant comprising one or more of oxygen, fluorine, chlorine, bromine, and iodine.

225. The temperature control method of claim 221 wherein the reactor is configured and able to deliver more diluent then the amount sufficient to saturate the co-reactant containing fluid.

226. The control method of claim 221 wherein the heated component receives heat from one of the energetic fluid and the expanded fluid, comprising one or more of a component of the reactor, a component of the expander, and a heat exchanger.

227. The control method of claim 221 wherein the heated component comprises an internally heated component which generates heat, wherein the internally heated component comprises one or more of a generator, a motor, a bearing, a mechanical drive, an electromagnetic converter, and an electromagnetic controller.

228. The control method of claim 227 further comprising delivering heated diluent to cool another heated component.

229. The control method of claim 227 further comprising delivering heated diluent to a heat application.

230. The control method of claim 227 further comprising delivering heated diluent to the reactor.

231. A method of converting energy in an energy-conversion system, the energy-conversion system comprising:

a method of delivering oxidant using an oxidant delivery system, the oxidant delivery system having an inlet and an outlet configured to deliver an oxidant-containing fluid into the energy-conversion system;

a method of delivery fuel using a fuel delivery system, the fuel delivery system being configured to deliver a fuel-containing fluid into the energy-conversion system;

a method of delivering diluent using a diluent delivery system, the diluent delivery system being configured to deliver diluent-containing fluid within the energy-conversion system, at least a portion of which comprises a vaporizable diluent fluid, and wherein at least a portion of diluent-containing fluid is pressurized as a liquid;

a method of combustion using a combustion system, the combustion system: being configured to receive fluid from the fuel delivery system, the oxidant delivery system, and the diluent delivery system; and including a combustion chamber having at least one inlet in fluid communication with the outlet of the oxidant delivery system and with the outlet of the fuel delivery system; having at least one outlet, the combustion system being configured to mix fuel-containing fluid and oxidant-containing fluid to form a combustible mixture of fuel and oxidant, to oxidize fuel with oxidant, whereby forming products of oxidation, and to deliver at least a portion of liquid diluent-containing fluid into the combustion chamber; the combustion system being further configured to deliver and mix diluent-containing fluid with one or more of oxidant-containing fluid, fuel-containing fluid and products of oxidation; to constrain the peak temperature of the energetic fluid exiting the combustion system; and to form an energetic fluid within the combustion system comprising products of oxidation, and vaporized diluent fluid, the energetic fluid having elevated levels of one or more of: temperature, pressure and kinetic energy;

a method of expansion using an expansion system, the expansion system comprising an expander having an inlet and an outlet configured to expand at least a portion of the energetic fluid, whereby forming an expanded fluid;

a method of heat and mass transfer using a heat and mass transfer system, the heat and mass transfer system having a plurality of inlets and outlets, being configured to: recover heat from the expanded fluid whereby forming a cooled expanded fluid; provide heat to the diluent-containing fluid whereby forming a heated

diluent fluid; deliver at least a portion of heated diluent fluid to the combustion system;

a method of recovering diluent using a diluent recovery system, the diluent recovery system being configured to recover diluent from the expanded fluid at least about equal to that delivered into the oxidant fluid or energetic fluid upstream of the outlet of the expansion system; and to recover a portion of one or both of the water formed during combustion and the water delivered with the oxidant fluid into the oxidant delivery system;

a method of treating fluid using a fluid treatment system, the fluid treatment system being configured to remove at least a portion of water recovered from the expanded fluid, wherein removing a portion of at least one contaminant in the expanded fluid and wherein reducing the concentration of the contaminant in the energetic fluid entering the expansion system.